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Signed K Behen

Dated 17 October 2003

Patents Form 1/77

Patents (. 1977
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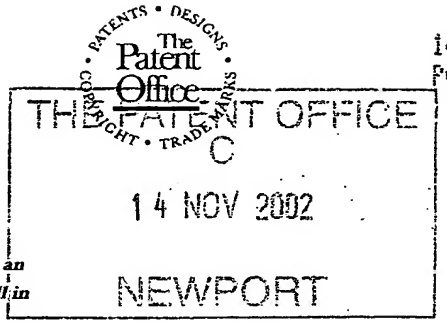

14NOV02 E763369-6 D02811
P01/7700 0.00-0226529.6

1/77

Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

The Patent Office

Cardiff Road
Newport
South Wales
NP10 8QQ

1. Your reference — A10724GB-DJL/ACL — 14 NOV 2002

2. Patent application number *(The Patent Office will fill in this part)* — 0226529.6

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

Dana Automotive Limited
Wood Lane
Erdington
Birmingham
B24 9QS

Patents ADP number *(if you know it)* 8338386002

If the applicant is a corporate body, give the country/state of its incorporation — United Kingdom

4. Title of the invention — Pump

5. Name of your agent *(if you have one)*

Forrester Ketley & Co.

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

Chamberlain House
Paradise Place
Birmingham
B3 3HP

Patents ADP number *(if you know it)* 133005

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*

a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or
c) any named applicant is a corporate body.
See note (d))

Yes

Patents Form 1/77

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	0
Description	6
Claim *(s)*	2
Abstract	1
Drawing *(s)*	4 +4 RM

10. If you are also filing any of the following, state how many against each item.

Priority documents	-
Translations of priority documents	-
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	-
Request for preliminary examination and search *(Patents Form 9/77)*	Yes
Request for substantive examination *(Patents Form 10/77)*	-
Any other documents *(please specify)*	-

11. I/We request the grant of a patent on the basis of this application.

Signature: Forrester Ketley & Co.

Date: 13 November, 2002

12. Name and daytime telephone number of person to contact in the United Kingdom: David J Lucking 0121 236 0484

Warning

After an application for a patent has been filed, the Comptroller of the Patent Office will consider whether publication or communication of the invention should be prohibited or restricted under Section 22 of the Patents Act 1977. You will be informed if it is necessary to prohibit or restrict your invention in this way. Furthermore, if you live in the United Kingdom, Section 23 of the Patents Act 1977 stops you from applying for a patent abroad without first getting written permission from the Patent Office unless an application has been filed at least 6 weeks beforehand in the United Kingdom for a patent for the same invention and either no direction prohibiting publication or communication has been given, or any such direction has been revoked.

Notes

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b) *Write your answers in capital letters using black ink or you may type them.*

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e) *Once you have filled in the form you must remember to sign and date it.*

f) *For details of the fee and ways to pay please contact the Patent Office.*

DUPLICATE

PATENTS ACT 1977

A10724GB-DJL/ACL

Title: Pump

Description of Invention

The present invention relates to a pump particularly to a pump including a power screw and at least one idler screw mounted in a housing, the idler screw which meshes with the power screw such that rotation of the power screw causes rotation of the idler screw.

Such a pump is commonly known as a screw pump, and pumping of fluid within the housing is effected by fluid becoming trapped and pressurised between the meshing screws.

Typically, such pumps include one or two cylindrical idler screws. Where two idler screws are provided they are typically mounted on diametrically opposite sides of the power screw. The idler screws need not be attached to the housing but may simply be retained within the housing. Alternatively, the idler screws may be mounted at an end in a bearing provided in the housing. In both cases, the pressure from the pumped fluid exerts a force on the idler screws which tends to push the idler screws away from the power screw into the housing. As a result, frictional forces between the idler screws and the housing can cause significant energy losses. This is a particular problem when the idler screws are not mounted in a bearing.

According to the invention we provide a pump including a power screw and at least one idler screw which meshes with the power screw, the power screw and idler screw being rotatable in a housing, the idler screw having at least one generally helical groove and at least one generally helical land surface, each land surface having a first and a second edge portion, each of which is adjacent to the groove or one of the grooves, the distance between the or at least one land surface and a longitudinal axis of the idler screw varying

between the first edge portion and the second edge portion over at least part of the length of the idler screw.

Preferably, the distance between the or the at least one land surface and a longitudinal axis increases from the first edge portion to the second edge portion, and the screw is arranged so that the first edge portion leads the second edge portion as the idler screw rotates in use.

By virtue of the shape of the idler screw, the pumped fluid acts as a hydrodynamic bearing, supporting the idler screw and reducing the frictional forces between the idler screw and the housing.

Preferably the power screw includes at least one a generally helical ridge which engages with the generally helical groove of the or each idler screw.

Preferably, each idler screw includes two generally helical grooves of substantially the same pitch and two generally helical land surfaces, each land surface having a first and a second edge portion, each of which is adjacent to a groove, the distance between each land surface and a longitudinal axis of the idler screw varying between the first edge portion and the second edge portion over at least part of the length of the idler screw. In this case, the power screw includes two generally helical ridges of substantially the same pitch.

Preferably the pump includes two idler screws located at diametrically opposite sides of the power screw.

The difference in the distance between the longitudinal axis of the idler screw and the land surface at the first edge portion and the second edge portion may be up to 4% of the largest distance between the longitudinal axis of the idler screw and the land surface.

An end of the or each idler screw may be mounted in a bearing provided in the housing.

The invention will now be described, by way of example only, with reference to the accompanying drawings, of which,

FIGURE 1 is an illustration of the driven, idler screws and housing of a pump according to the invention,

FIGURE 2 is an illustration of a transverse cross-section through the driven and idler screws of Figure 1.

FIGURE 3 is an illustration of a longitudinal section through a pump according to the invention, in the direction shown by arrow X in Figure 2.

FIGURE 4 is an illustration of a longitudinal section through a pump according to the invention in the direction shown by arrow Y in Figure 2.

Referring now to the figures, there is shown a power screw 10 and idler screws 12 of a screw pump, the two idler screws 12 located at diametrically opposite sides of the power screw 10. Longitudinal axes A of the idler screws 12 are generally parallel to the longitudinal axis B of the power screw 10. Each idler screw 12 includes first and second generally helical grooves 14, 14' which each extend along substantially the entire length of the screw 12. The two grooves 14, 14' are both of substantially the same pitch and sense, and the turns of the grooves 14, 14' are interposed such that when the screw 12 is viewed in transverse cross-section one groove 14 is diametrically opposite the other 14'.

The grooves 14, 14' are separated by first and second generally helical land surfaces 16, 16', each land surface having a first edge portion 16a, 16a' and second edge portion 16b, 16b' adjacent to one of the grooves 14, 14'. The first edge portion 16a of the first land surface 16 is adjacent to the second groove 14' and the second edge portion 16b of the first land surface 16 is adjacent to the first groove 14. The first edge portion 16a' of the second land surface 16' is adjacent to the first groove 14, and the second edge portion 16b' of the second land surface 16' is adjacent to the second groove 14'.

The distance between each land surface 16, 16' and the longitudinal axis A of the idler screw 12 increases from the first edge portion 16a, 16a' to the second edge portion 16b, 16b'. Typically, the difference in the distance between the first edge portion 16a, 16a' of each land surface 16, 16' and the

longitudinal axis A and the distance between the second edge portion 16b, 16b' of each land surface 16, 16' and the longitudinal axis A is up to 4% of the largest outside diameter of the idler screw 12, i.e. the distance between the second edge portion 16b, 16b' of each land surface 16, 16' and the longitudinal axis A. Thus it is apparent that this difference has been exaggerated in Figure 2 for clarity.

The power screw 10 is provided with first 18 and second 18' generally helical ridges which each extend along substantially the entire length of the screw 10. The two ridges 18, 18' are both of substantially the same pitch & sense, and the turns of the ridges 18, 18' are interposed such that when the screw 10 is viewed in transverse cross-section one ridge 18 is diametrically opposite the other 18'.

The first ridge 18 meshes with the first groove 14 of each idler screw 12, and the second ridge 18' meshes with the second groove 14' of each idler screw 12, and thus rotation of the power screw 10 about its longitudinal axis B causes rotation of the idler screws 12 about their longitudinal axes A.

The power screw 10 and idler screws 12 are mounted in a housing 20, part of which is illustrated in Figures 2, 3 & 4 which is shaped to provide minimum clearance between the screws 10, 12 and the housing 20, whilst permitting rotation of the screws 10, 12 within the housing 20. The housing 20 thus includes an elongate cavity in which the screws 10, 12 are housed. In cross-section, the cavity includes a central part circular portion 20a of a larger diameter adapted to house the power screw 10, and two part circular lobe portions 20b located on diametrically opposite sides of the central portion of 20a, which each have a smaller diameter and are adapted to house the idler screws 12.

As illustrated in Figures 3 & 4, the housing 20 also includes an outlet port 22 and an inlet port 24, the inlet port 24 being arranged such that fluid enters the cavity adjacent to first ends of the driven and idler screws 10, 12 and

the outlet port 22 being arranged such that fluid leaves the cavity adjacent to second ends of the driven and idler screws 10, 12. The inlet port 24 is connected to a supply of fluid to be pumped.

The power screw 10 is connected to a motor (not shown) by means of a drive shaft 26, the drive shaft 26 being mounted in bearings 28 provided in the housing 20. Operation of the motor causes the power screw 10 to rotate about its longitudinal axis B in a first sense, and which thus causes the idler screws 12 each to rotate about their longitudinal axes A in an opposite sense to the power screw 10. The screws 10, 12 are oriented such their rotation causes fluid to be drawn from the inlet port and moved along the length of the screws 10, 12 to the outlet port. Fluid trapped between the ridges 18, 18' and the grooves 14, 14' as the screws 10,12 mesh becomes pressurised and exerts an outward force on both the idler screws 12, which tends to push the idler screws 12 towards the housing 20.

The idler screws 12 are configured such that the first edge portions 16a, 16a' of each land surface 16, 16' lead the second edge portions 16b, 16b' as the idler screws 12 rotate. The resulting change in separation between the land surfaces 16, 16 and the housing 20 compresses the fluid between the housing 20 and the land surfaces 16, 16', the resultant local fluid pressures enable the fluid to act as a hydrodynamic bearing, supporting the idler screws 12, and reducing frictional forces between the housing and the land surfaces 16, 16' of the idler screws 12. Thus, the efficiency of the pump is improved.

Such a pump advantageously is used to pump fluid for hydraulic systems which may include actuators.

In this example, the idler screws 12 are not connected to the housing 20, but it is possible to mount the idler screws 12 on bearings connected to the housing 20.

It is not necessary to provide each idler screw 12 with two grooves 14, 14' and the power screw 10 with two ridges 18, 18'. Each idler screw 12 may

be provided with one or more than two grooves 14, 14', and the power screw 10 provided with a corresponding number of ridges 18, 18'.

The features disclosed in the foregoing description, or the following claims, or the accompanying drawings, expressed in their specific forms or in terms of a means for performing the disclosed function, or a method or process for attaining the disclosed result, as appropriate, may, separately, or in any combination of such features, be utilised for realising the invention in diverse forms thereof.

CLAIMS

1. A pump including a power screw and at least one idler screw which meshes with the power screw, the power screw and idler screw being rotatable in a housing, the idler screw having at least one generally helical groove and at least one generally helical land surface, each land surface having a first and a second edge portion, each of which is adjacent to the groove or one of the grooves, the distance between the or at least one land surface and a longitudinal axis of the idler screw varying between the first edge portion and the second edge portion over at least part of the length of the idler screw.

2. A pump according to claim 1 wherein the distance between the or the at least one land surface and a longitudinal axis increases from the first edge portion to the second edge portion, and the screw is arranged so that the first edge portion leads the second edge portion as the idler screw rotates in use.

3. A pump according to claim1 or 2 wherein the power screw includes a generally helical ridge which engages with the generally helical groove of the or each idler screw.

4. A pump according to any preceding claim wherein each idler screw includes two generally helical grooves of substantially the same pitch and two generally helical land surfaces, each land surface having a first and a second edge portion, each of which is adjacent to a groove, the distance between each land surface and a longitudinal axis of the idler screw varying between the first edge portion and the second edge portion over at least part of the length of the idler screw.

5. A pump according to claim 4 wherein the power screw includes two generally helical ridges of substantially the same pitch.

6. A pump according to any preceding the pump includes two idler screws located at diametrically opposite sides of the power screw.

7. A pump according to any preceding claim wherein the difference in the distance between the longitudinal axis of the idler screw and the land surface at the first edge portion and the second edge portion is up to 4% of the largest distance between the longitudinal axis of the idler screw and the land surface.

8. A pump according to any preceding claim wherein an end of the or each idler screw is mounted in a bearing provided in the housing.

9. A pump substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

10. Any novel feature or novel combination of features described herein and/or in the accompanying drawings.

ABSTRACT

Title: Pump

A pump including a power screw (10) and at least one idler screw (12) which meshes with the power screw (10), the power screw (10) and idler screw (12) being rotatable in a housing (20), the idler screw (12) having at least one generally helical groove (14, 14') and at least one generally helical land surface (16, 16'), each land surface (16, 16') having a first (16a, 16a') and a second (16b, 16b') edge portion, each of which is adjacent to the groove or one of the grooves (14, 14'), the distance between the or at least one land surface (16, 16') and a longitudinal axis (A) of the idler screw (12) varying between the first edge portion (16a, 16a') and the second edge portion (16b, 16b') over at least part of the length of the idler screw (12).

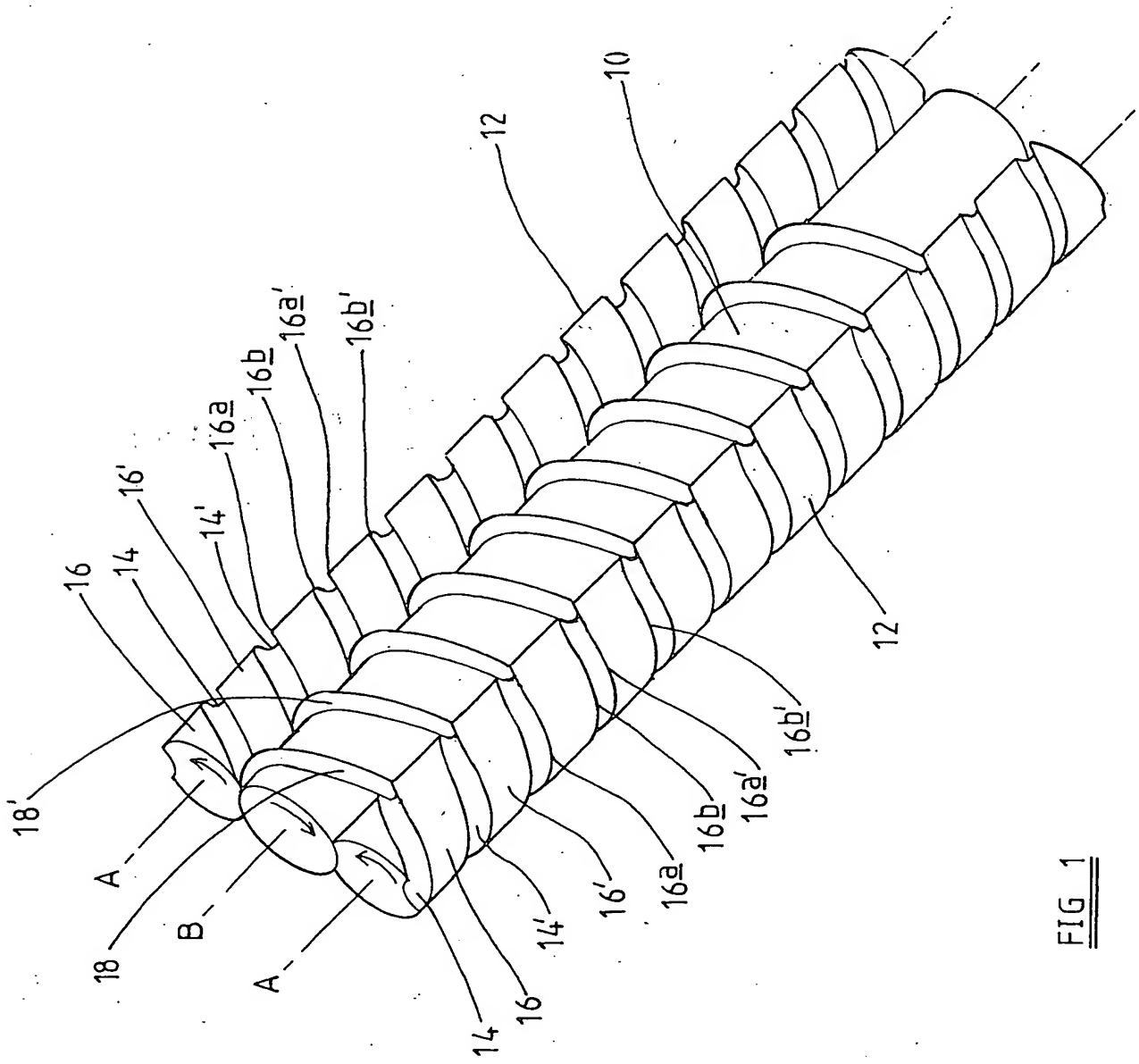
10
12
16b'
16a'
16b
16a
16'
14'
14
16
18
18'
A
B
A
16
14
16'
14'
16a
16b
16a'
16b'
12

FIG 1

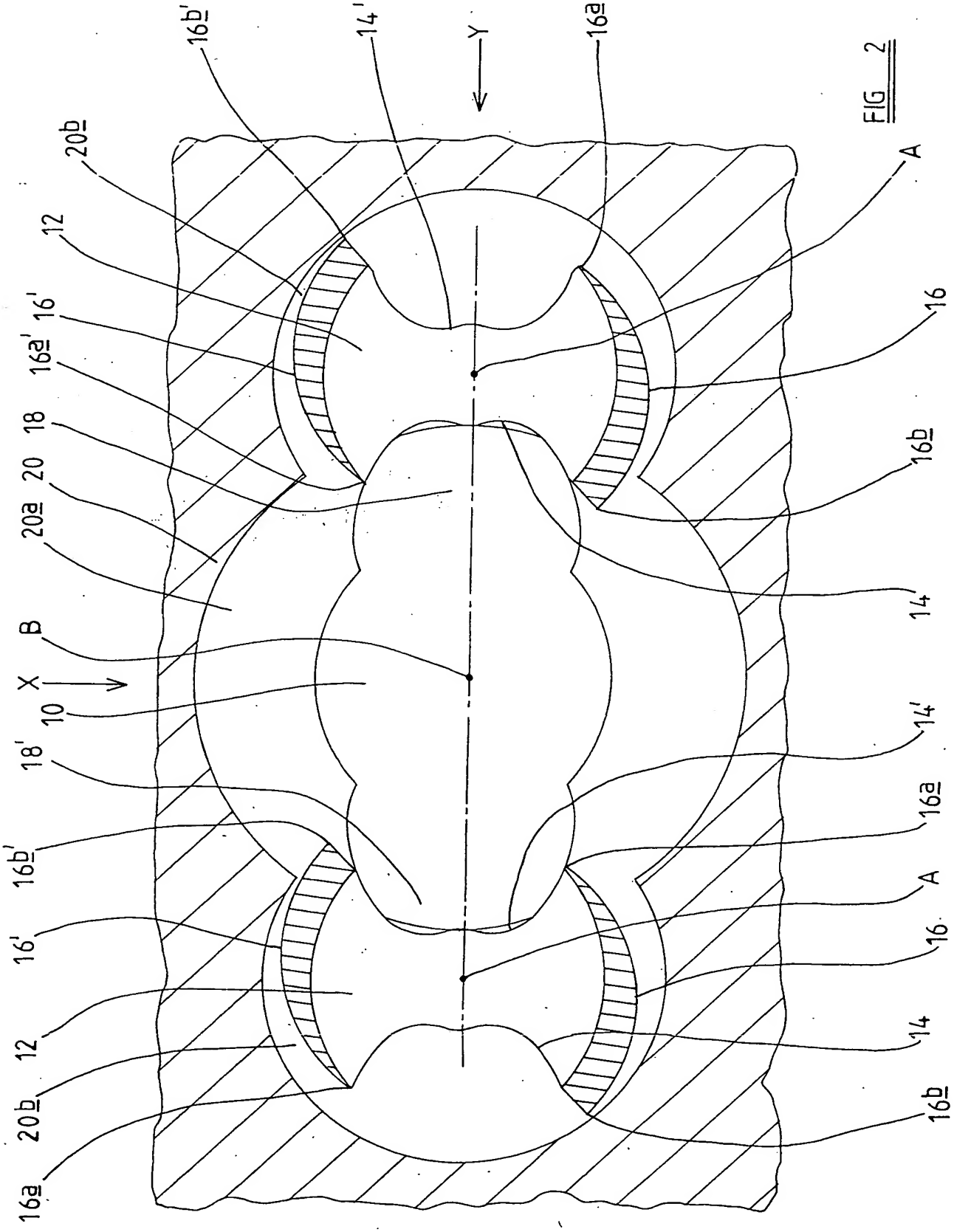
16b'
14'
Y
16a
20b
12
16'
16a'
18
20
20a
B
X
10
18'
16b'
16'
12
20b
16a
A
16
16b
14
14'
16a
A
16
14
16b

FIG 2

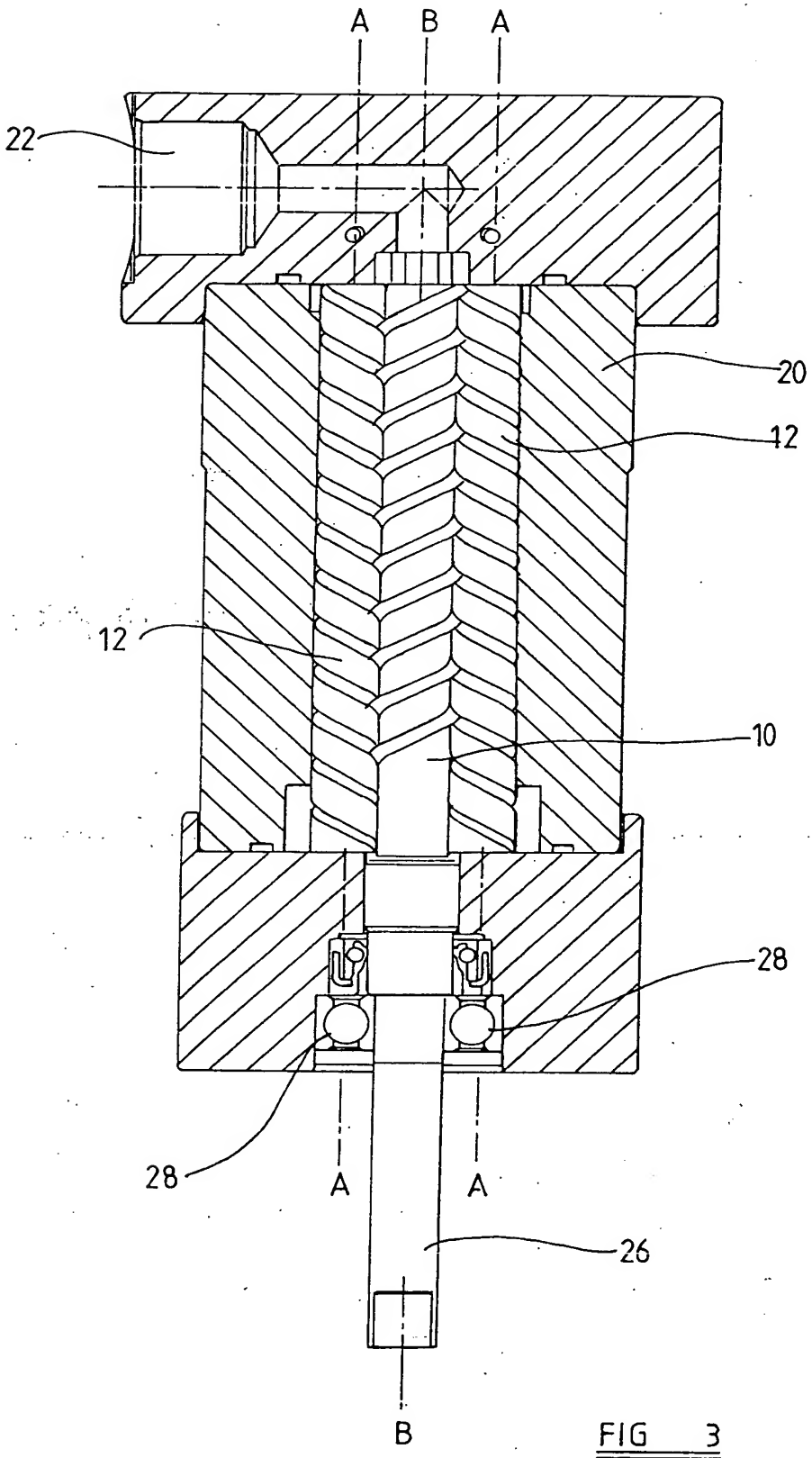

FIG 3

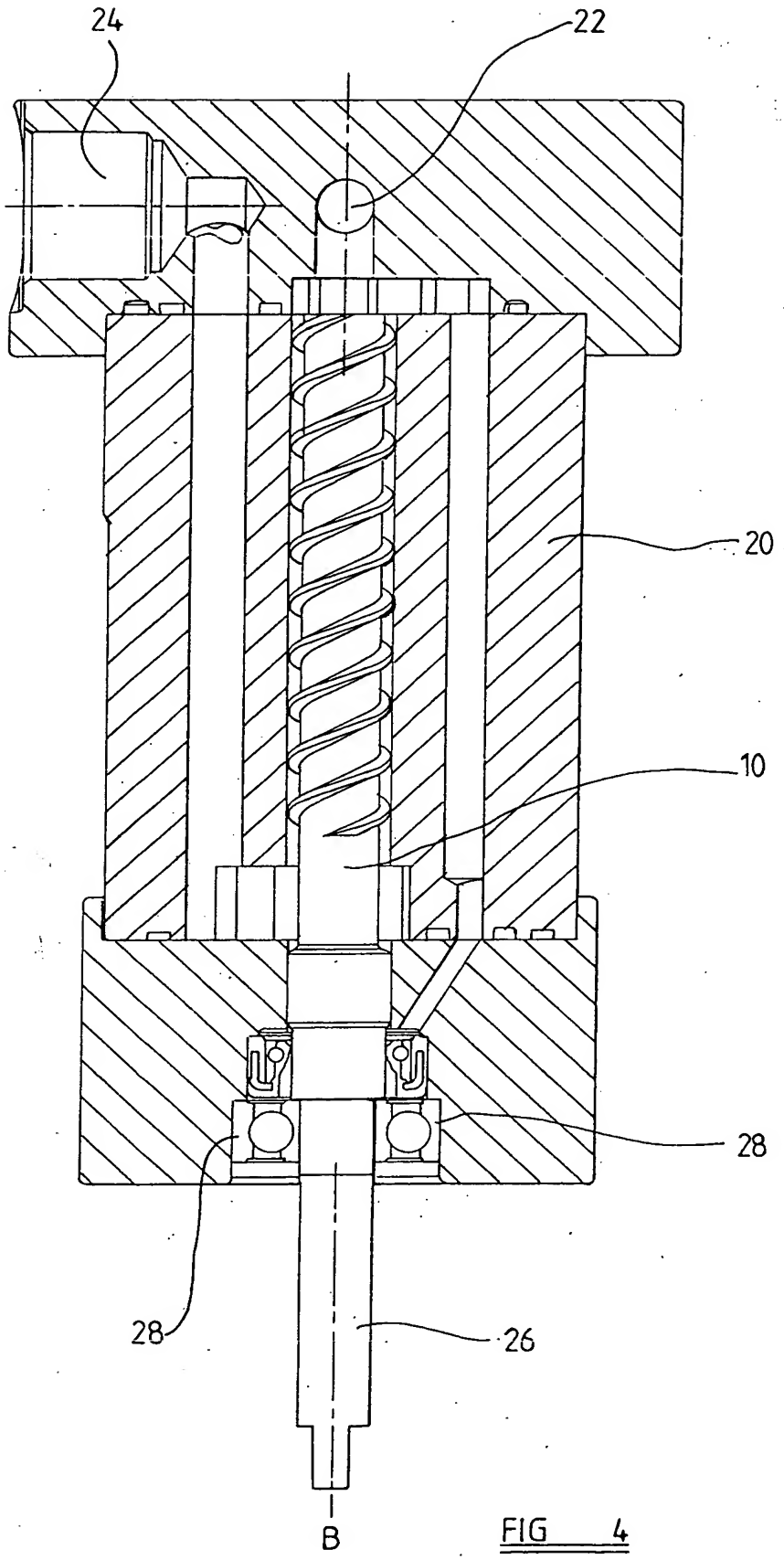

FIG 4